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ABSTRACT

This study investigated the utility of aptitude and learning rates for initial study units as predictors of time-to-mastery in an individualized, mastery-based course taught largely by TICCIT (Time-Shared, Interactive, Computer-Controlled Information Television) computer assisted instruction. A TICCIT student station includes a color television, a keyboard with specialized learner-control keys, and a light pen. Emphasis is on learner control over the instructional process. Subjects were 102 marines who graduated from the Communication Center Operator Course, which is designed to train students to work in communications centers throughout the Marine Corps. The Armed Services Vocational Aptitude Battery was utilized as an aptitude measure. Aptitude alone proved to be a weak predictor, accounting for only 12% of the variance in total time-to-mastery. By using both aptitude and initial unit learning times, 40% of the variance was explained. Results suggest that learning times over initial units may prove more useful than pre-course measures of aptitude in the prediction of time-to-mastery in individualized instruction. (Author/LMM)

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PREDICTING STUDENT PERFORMANCE IN A COMPUTER-ASSISTED INSTRUCTION COMMUNICATION CENTER OPERATOR COURSE IN THE MARINE CORPS

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Abstract

This study sought to ascertain the utility of aptitude and initial learning rates as predictors of time-to-mastery in a protracted communication center operator course taught largely by TICCIT (Time-shared, Interactive, Computer-Controlled Information Television) computer-assisted instruction. The subjects of this study were 102 marines. Aptitude alone proved to be a weak predictor, accounting for 12 percent of the variance in total time-to-mastery. By using both aptitude and initial unit learning times, 40 percent of the variance was explained. The results suggest that learning times over initial units may prove more useful than pre-course measures of aptitude in the prediction of time-to-mastery in individualized instruction.

Predicting Student Performance in a Computer-Assisted Instruction Communication Center Operator Course in the Marine Corps

In recent years the military services have made a substantial commitment to individualized modes of instruction in technical training. The impetus for this change is: (1) widely varying aptitudes and educational skills of entering military personnel, and (2) requirements to train these personnel to operate and maintain increasingly more sophisticated military equipment. Individualized instruction in the military typically establishes performance criteria or mastery levels that all students are expected to attain. Course progress and graduation are dependent on the attainment of these criteria. Freed from the fixed time constraints of conventional group-based instruction, students progress through prescribed learning tasks at individual rates. Individualized modes of instruction thus tend to hold achievement constant while allowing individual learning times to vary.

Many researchers have shifted their attention from individual differences in level of achievement to individual differences in time needed to attain mastery. Bloom (1974) considers this a significant and desirable shift in the study of the learning process. Numerous studies have shown learning rates in mastery-based instruction to be related to aptitude.

In his model of school learning, Carroll (1963) defined aptitudes as the amount of time needed to reach criterion and stated that the amount of time needed could be predicted by appropriate aptitude tests. Bloom reported that the correlation between aptitude scores and time to criterion range from .5 to .7. Substantially lower correlations were yielded when Federico and Landis (1979) used a battery of aptitude and ability tests to predict module completion times of Navy students in a Computer-Managed (CMI) basic electronics course.

Gettinger and White (1979) and Block (1974) have reported wide variability in student learning rates under individualized conditions. When the slowest 5 percent of the students in a class were compared with the fastest 5 percent on initial learning units, ratios of as high as 7 to 1 are reported. In later units of the course, these ratios are described as decreasing to as low as 1.5 to 1, as students become more efficient in their learning processes. Cronbach and Snow (1977) attribute this decreasing variability in times-to-mastery as a course progresses to a "learning-to-learn" process. They state that it would be important to know whether persons who do relatively well on early tasks, maintain this advantage throughout a course. They believe it possible that ability has little predictive power in individualized educational settings where people accumulate relatively long term experience with similar tasks. These ideas are consistent with Wang's (1980, 1983) and Bloom's (1980) suggestions that students'

capacities to learn in individualized instruction are not static, but highly dynamic and subject to alteration.

The time required to master the first parts of a course may be a good predictor of a student's eventual degree of adaptation to a specific type of instruction and the learning tasks within it. These times could be more relevant in the prediction of the time needed to master a course than paper and pencil tests of aptitude. The focus of this paper will be to ascertain whether initial unit times-to-mastery can be used to enhance the power of aptitude in the prediction of total course times-to-mastery.

Method

The subjects in this study were 102 marines who graduated from the Communication Center Operator Course (CCOC). CCOC is an individualized, mastery-based course that makes extensive use of computer-assisted instruction (CAI). The large majority of students report to CCOC after graduation from recruit training. Ninety-six percent of the sample were high school graduates. Females comprised 14 percent of the sample. Students were included in the sample if two criteria were met. Their service record books had to contain scores on the latest version of the Armed Services Vocational Aptitude Battery (Sims & Truss, 1980), and their CAI course history had to be complete. Less than 10 percent of the initial sample was lost due to failure to meet these criteria. A graduates-only sample was considered appropriate because attrition from CCOC due to academic reasons is rare.

The purpose of CCOC is to train students to work in communications centers throughout the Marine Corps. The course is heavily oriented towards the teaching of procedures. Students become proficient in the operation of a variety of communications equipments, learn how to properly format and send different types of messages, and learn the administrative skills necessary to work in a communications center. All students complete seven units of CAI instruction. The subject matter of these CAI units is delineated in Table 1. Students spend approximately 65 percent of their course time learning by CAI. The remaining time is spent developing typing proficiency and in hands-on application of newly acquired knowledge.

Insert Table 1

The CAI system utilized by CCOC is the Time-Shared Interactive Computer-Controlled Information Television (TICCIT) system. A TICCIT student station consists of a color television, a keyboard that includes specialized learner-control keys, and a light pen. The TICCIT teaching strategy places much emphasis on learner-control over the instructional process. By using the learner-control keys, students control the presentation of the material to be learned (Rule), examples of its application (Example), and problems for practice on its application (Practice). The Rule portion of instruction is available to the student at different levels of elaboration and reading grade

levels. The Example and Practice functions are available at several levels of difficulty. The student has complete control over the sequence and levels of these functions. TICCIT also has an "Advisor" function that will make suggestions if the student gives evidence of having difficulty.

Course progress is dependent on the student's demonstrating mastery on the unit tests, which are administered by TICCIT. Mastery level in CCOC is typically set at 90 percent on the various tests in the course. TICCIT maintains records on each student, which include test performance data and time needed by the student to demonstrate mastery of each portion of the course. The seven unit times used in this study consist of the CAI instructional time needed by the student prior to demonstrating mastery on the unit exam. Further information about the TICCIT system is available elsewhere (Alderman, 1978; Reigeluth, 1979).

Insert Table 2

The Armed Services Vocational Aptitude Battery (ASVAB) was utilized as the measure of aptitude in this study. The ASVAB (Forms 8, 9, and 10) is a battery of 10 subtests that is used for selecting enlistees and placing them in military occupations. Various subtests are combined into composite scores that are predictive of performance in general occupational areas. Seven of the composites used by the Marine Corps are listed

in Table 2. The Marine Corps uses the Clerical (CL) aptitude composite as a selection consideration in assigning students to CCOC. It desires a student to have a minimum CL of 100 (50th percentile nationally). This is not, however, an inflexible requirement.

Results

Correlations were first computed between the various ASVAB composites scores and the total CAI time-to-mastery for the course. The ASVAB composite score means, standard deviations, and correlations with total time-to-mastery are shown in Table 2. The Clerical (CL) and General Technical (GT) aptitude composites emerged as being the best predictors ($r = -.35$) of total time-to-mastery. The CL and GT composites share two common subtests (Word Knowledge and Paragraph Comprehension) and are moderately correlated ($r = .51$). To maintain independence of predictors, it was decided to use only the CL composite as the aptitude component of this study. The four subtests that make up the CL composite are described in Table 3.

Insert Table 3

Examination of the descriptive statistics in Table 4 shows considerable variability in the unit and total times-to-mastery. The slowest student required a little over four times the hours to demonstrate mastery of the seven units as did the fastest student. The mean total time for the slowest and fastest five

percent of the students was 203.30 and 61.41 hours respectively, a ratio of 3.3 to 1.

Correlations among the unit times, total times, and the CL aptitude composite are presented in Table 4. The correlations of the CL composite with the unit times were low, all falling in the -.19 to -.33 range. Moderate correlations in the .42 to .66 range exist when a unit time is used to predict the next unit time. As might be expected, unit times are generally best able to predict the times of units that immediately follow, and are somewhat less predictive of units with greater temporal separation.

Insert Table 4

Hierarchical regression analyses were used to analyze the predictive contributions of the CL composite, Unit 1 time, and Unit 2 time in accounting for variance in unit and total times. In hierarchical regression, predictors are entered cumulatively in a specified order. In each of the ten regressions, CL was entered first to ascertain the contribution of aptitude alone to explained variance in times. Unit 1 time was entered second and Unit 2 time third. In order to use Unit 1 and Unit 2 times to predict total course time, two new variables were created: total time with Unit 1 time removed and total time with both Unit 1 and Unit 2 removed. Summaries of the regression analyses are presented in Table 5. Figure 1 is a graphic depiction of

the increase in accounted for variance in times with the inclusion of each predictor.

Insert Table 5

The regression analyses show that the CL composite is a rather weak predictor by itself, accounting for no more than 11 percent of the variance in the individual unit times, and only 12 percent of the total course time. As can be seen in Figure 1, modest improvements in the accounted for variance are made with the inclusion of Unit 1 time as a predictor. Dramatic improvement in predictive power is made with the inclusion of Unit 2 time. The accounted for variance in Units 3, 4, 5, and 6 more than doubled. The accounted for variance in total course time (minus Units 1 and 2) jumps from 16 to 40 percent.

Insert Figure 1

Discussion

Previous studies (Bloom, 1974; Federico & Landis, 1979) have reported that aptitude is predictive of time-to-mastery in individualized instruction. The purpose of this study was to investigate whether initial unit learning times can provide additional predictive power, when used in conjunction with aptitude. The results of this study suggest that initial

learning times do have predictive utility beyond that provided by aptitude.

The relatively low contribution of the CL composite to explained variance in time-to-mastery could be due to several reasons. The students involved in this study had been selected for assignment to the school based on having above average CL composites. Thus, there may have been some truncation in the range of CL scores which could lesson the explained variance. The TICCIT system is designed to be an adaptive system. It has the capability to provide the learner with the sequence of instructional events and the level of instruction desired. An adaptive CAI system may minimize the effects of aptitude on time-to-mastery. TICCIT is a highly lexical instructional medium, however, and it would seem that the ASVAB Word Knowledge and Paragraph Comprehension subtests would enhance the predictive power of the CL composite.

The addition of Unit 2 times to the CL and Unit 1 time predictors adds much to the predictive power of the set. Unit 1 is a relatively short block of instruction, completed by the average student in seven hours or so. This may not be long enough for the student to adapt to the system or to establish a stable learning rate. The student may still be in the learning-to-learn process described by Cronbach and Snow (1977). The average student has nearly 32 hours of CAI when Unit 2 is completed. By this time adaptation to the system may be further along, and learning rates more stabilized.

Simple measures of time spent in the initial units of an individualized course may have practical utility for those who have a need to predict the duration of students' tenure in an individualized course. These initial learning times may prove better than pre-course measures of aptitude in predicting a learner's eventual adaptation to specific instructional environments and kinds of learning tasks.

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Author Notes

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Table 1

Subject Matter of CCOC CAI Units

Unit	Subject Matter
1	Basic Communications terminology, regulations, and safety standards
2	Organization of DOD communications network and basic message preparation and format procedures
3	Use of standard communications publications in the operation of a communications center
4	Operating characteristics of various high speed computers
5	Message preparation procedures using Autodin equipment
6	Advanced message preparation and handling procedures
7	Job responsibilities, message flow within communication center, and filing procedures

Table 2

ASVAB Aptitude Composite Descriptive Statistics and Correlations with Total Time-to-Mastery

ASVAB Composite	Mean	SD	Correlation with Total Time-to-Mastery
General Technical	106.09	10.27	-.35 **
General Maintenance	101.15	13.48	-.11
Electronics	105.28	11.33	-.17
Clerical	112.69	10.26	-.35 **
Mechanical Maintenance	98.84	12.48	-.15
Combat	104.34	11.59	-.24 *
Field Artillery	101.74	12.24	-.25 *

N = 102
*p<.05
**p<.01

Table 3

Description of ASVAB Subtests
Comprising Clerical Aptitude Composite

Subtest	Description
Numerical Operations	A 50-item speeded mathematical test requiring elementary addition, subtraction, multiplication, and division
Coding Speed	An 84-item speeded test requiring short term memory and perceptual motor speed
Word Knowledge	A 35-item power test measuring vocabulary knowledge
Paragraph Comprehension	A 15-item power test requiring comprehension of written passages

Table 4

Means, Standard Deviations, Minimums, Maximums, and Correlations of Time-to-Mastery and CL Aptitude

Variable	Mean	SD	Min	Max	Correlations (a)										
					(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
(1) Unit 1 Hrs.	7.37	3.36	2.02	22.67	1.00										
(2) Unit 2 Hrs.	23.44	6.97	11.20	41.75	.41	1.00									
(3) Unit 3 Hrs.	14.49	5.31	4.87	31.73	.33	.50	1.00								
(4) Unit 4 Hrs.	20.26	8.71	3.40	46.62	.29	.57	.64	1.00							
(5) Unit 5 Hrs.	25.38	11.92	7.33	77.27	.26	.50	.50	.65	1.00						
(6) Unit 6 Hrs.	21.89	7.16	9.60	43.35	.18	.49	.39	.53	.66	1.00					
(7) Unit 7 Hrs.	8.38	3.57	2.85	16.78	.22	.36	.41	.52	.49	.47	1.00				
(8) Total Hrs.	121.01	35.87	48.83	221.02	.44	.74	.72	.85	.86	.76	.63	1.00			
(9) Total-Unit 1 (b)	113.64	34.54	45.73	209.70	.36	.73	.71	.85	.87	.78	.64	.99	1.00		
(10) Total-Unit 1&2 (c)	90.20	29.81	32.65	181.22	.32	.62	.71	.85	.89	.79	.65	.98	.99	1.00	
(11) CL Aptitude	112.69	10.26	78.00	152.00	-.24	-.33	-.19	-.22	-.28	-.29	-.27	-.35	-.34	-.31	1.00

(a) For N = 102, correlations of .19 are significant beyond the .05 level, correlations of .25 or greater are significant beyond the .01 level

(b) Total course hours with Unit 1 hours subtracted

(c) Total course hours with Unit 1 and Unit 2 hours subtracted

Table 5

Summary of Hierarchical Regression Analyses
for Unit and Course Times

Step No.	Variable Entered	Multiple R	Multiple R^2	Increase in R^2	F-to-Enter
		Unit 1 Time			
1	CL	.24	.06	.06	6.24 *
MS(Regression) = 66.95; F(1,100) = 6.24; p <.05; S.E.E.= 3.27					
UNIT1HRS = 16.31 - .08 CL					
		Unit 2 Time			
1	CL	.33	.11	.11	12.44 **
2	UNIT1HRS	.47	.22	.11	14.28 **
MS(Regression) = 546.93; F(2,99) = 14.19; p <.001; S.E.E.= 6.21					
UNIT2HRS = 3.72 - .17 CL + .72 UNIT1HRS					
		Unit 3 Time			
1	CL	.19	.04	.04	3.55 N.S.
2	UNIT1HRS	.35	.12	.08	9.86 **
3	UNIT2HRS	.52	.27	.15	36.79 ***
MS(Regression) = 258.67; F(3,98) = 12.26; p <.001; S.E.E. = 4.59					
UNIT3HRS = 4.93 + .001 CL + .24 UNIT1HRS + .34 UNIT2HRS					
		Unit 4 Time			
1	CL	.22	.05	.05	5.13 *
2	UNIT1HRS	.33	.11	.06	6.15 *
3	UNIT2HRS	.57	.32	.21	32.31 ***
MS(Regression) = 839.59; F(3,98) = 16.00; p <.001; S.E.E. = 7.24					
UNIT4HRS = 5.81 - .02 CL + .17 UNIT1HRS + .67 UNIT2HRS					

*p<.05
**p<.01
***p<.001

Table 5 (Continued)

Step No.	Variable Entered	Multiple R	Multiple R^2	Increase in R^2	F-to-Enter
		Unit 5 Time			
1	CL	.28	.08	.08	8.80 **
2	UNIT1HRS	.35	.12	.04	4.35 *
3	UNIT2HRS	.52	.27	.15	19.55 ***
MS(Regression) = 1,272.57; F(3,98) = 11.84; p <.001; S.E.E. = 10.37 UNIT5HRS = 23.27 - .15 CL + .19 UNIT1HRS + .74 UNIT2HRS					
		Unit 6 Time			
1	CL	.29	.09	.09	9.35 **
2	UNIT1HRS	.31	.10	.01	1.46 N.S.
3	UNIT2HRS	.51	.26	.16	33.69 ***
MS(Regression) = 441.79; F(3,98) = 11.23; p <.001; S.E.E.= 6.27 UNIT6HRS = 23.58 - .11 CL + .08 UNIT1HRS + .46 UNIT2HRS					
		Unit 7 Time			
1	CL	.27	.07	.07	7.96 **
2	UNIT1HRS	.31	.10	.03	2.70 N.S.
3	UNIT2HRS	.40	.16	.06	7.30 **
MS(Regression) = 69.04; F(3,98) = 6.26; p <.001; S.E.E. = 3.32 UNIT7HRS = 10.82 - .06 CL + .07 UNIT1HRS + .15 UNIT2HRS					
		Total CAI Time			
1	CL	.34	.12	.12	13.80 ***
MS(Regression) = 15766.40; F(1,100) = 13.80; p <.001; S.E.E. = 33.80 TOTALTIME = 258.23 - 1.21 CL					

*p<.05
**p<.01
***p<.001

Table 5 (Continued)

Step No.	Variable Entered	Multiple R	Multiple R^2	Increase in R^2	F-to-Enter
		Total Time with Unit 1 Removed			
1	CL	.34	.12	.12	12.91 ***
2	UNIT1HRS	.44	.19	.07	9.77 **
MS(Regression) = 11683.80; F(2,99) = 11.91; p <.001; S.E.E. = 31.32 TOTAL TIME MINUS UNIT 1 = 193.19 - .90 CL + 2.99 UNIT1HRS					
		Total Time with Units 1 and 2 Removed			
1	CL	.31	.10	.10	10.94 **
2	UNIT1HRS	.40	.16	.06	7.28 **
3	UNIT2HRS	.63	.40	.24	38.09 ***
MS(Regression) = 11830.20; F(3,98) = 21.36; p <.001; S.E.E. = 23.53 TOTAL TIME MINUS UNITS 1 AND 2 = 68.41 - .33 CL + .59 UNIT1HRS + 2.35 UNIT2HRS					

*p<.05
**p<.01
***p<.001

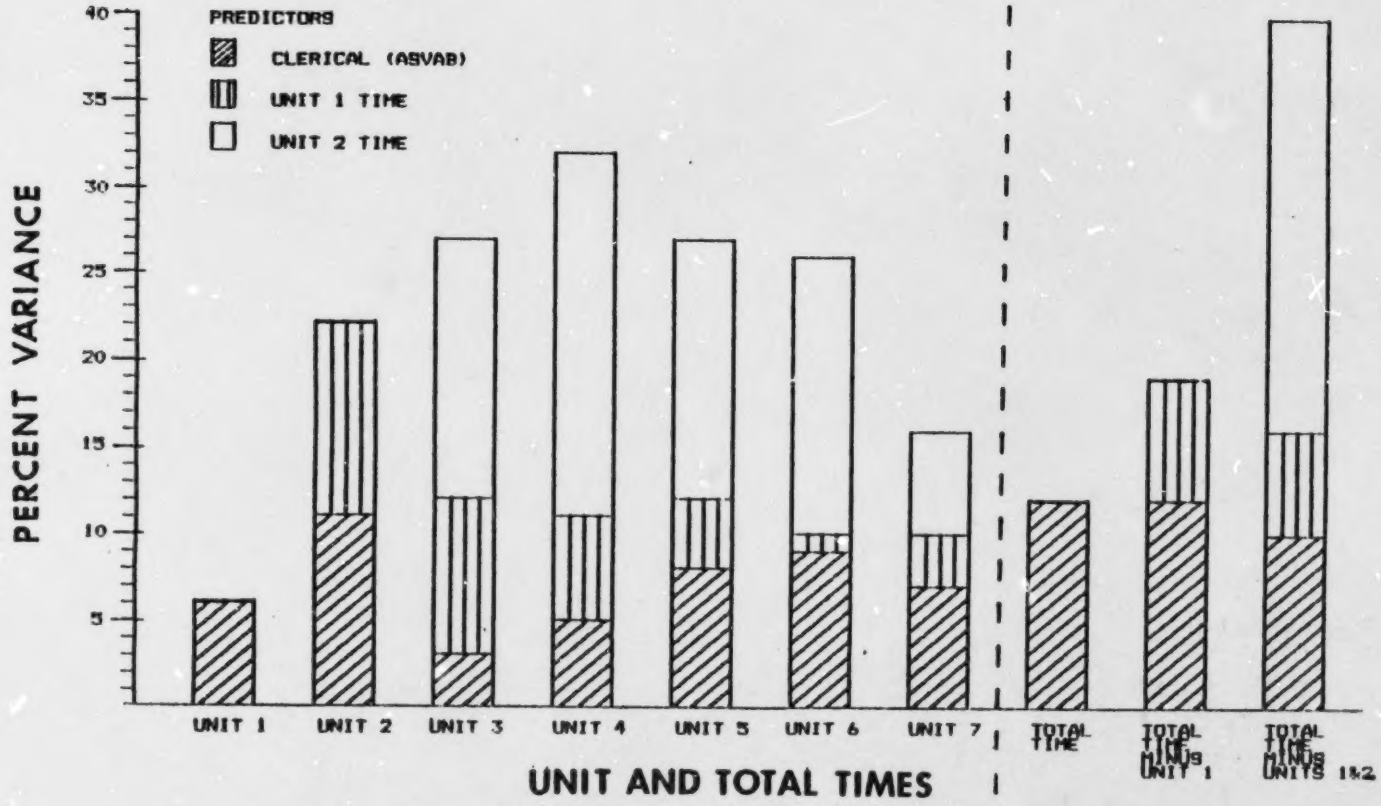

Figure 1. Percent variance of unit and course times accounted for by aptitude and initial unit times-to-mastery.